NOTES ON THE HOLOTHURIOIDEA OF THE INDIAN OCEAN.

By Joseph Pearson.

(With ten Plates.)

1.—THE GENUS HOLOTHURIA.

THE following notes on the littoral Holothurioidea of the Indian Ocean have been brought together during the preparation of a monograph on the subject. Zoogeographically the Indian Ocean cannot be separated from the tropical portion of the Pacific, since with few exceptions the species of littoral Holothurians of this region have a wide distribution extending from the east coast of Africa to the eastern portion of the Pacific. The majority of the Holothurians of Ceylon, for instance, occur throughout the tropical waters of the Indo-Pacific region, and are found on the east coast of Africa from Suez to the Cape of Good Hope, the coast of Asia from the northern end of the Red Sea to the islands of Japan, the East Indies, the north coast of Australia, the Pacific Islands, and in some cases the western coast of South America. On the grounds of not having sufficient material from the Pacific Ocean, and also in order to confine the work within reasonable limits, it has been decided to include only those Holothurians found in the waters which lie between latitudes 30° N. and 30° S. and longitudes 30° E. and 130° E.

The proposed monograph will be based upon collections examined and described by the present writer during the past few years. I refer to the collections made by Professor Herdman, F.R.S., in Ceylon, by Messrs. Simpson and Rudmose Brown in the Mergui Archipelago, by Mr. Simpson in Portuguese East Africa, and to the collection of Holothurians in the Colombo Museum. To these have been added the Holothurians sent by Professor Stanley Gardiner, F.R.S.,

from the Maldives and the Seychelles, a collection from the Red Sea sent by Mr. Cyril Crossland, Marine Biologist to the Sudan Government, and the collections made by the Federal Investigation ship "Endeavour" and the R. I. M. S. "Investigator" (other than those already described by MM. Koehler and Vaney). Through the kindness of the authorities concerned I have also been able to examine a very large and varied collection of Holothurians from the following Museums: the Indian Museum, Calcutta; the Australian Museum, Sydney; the South African Museum, Cape Town; the Durban Museum, Natal; the National Museum of Ireland, Dublin; the United States National Museum, Washington, D.C.; the Museum of Comparative Zoology, Harvard, Cambridge, Mass.; Zoologisches Institut, Kgl. Bayerische Universitat, Munich; Naturhistorisches Museum der Senckenbergischen Naturforschenden Gesellschaft, Frankfürt; Museum d'Histoire Naturelle, Geneva. An interesting collection has also been received from the Science College, Imperial University, Tokyo.

The following species are described in the present Paper :—

Holothuria hamata, n. sp.
Holothuria maculosa, n. sp.
Holothuria marmorata (Jäger).
Holothuria argus (Jäger).
Holothuria vitiensis, Semper.
Holothuria graffei, Semper.
Holothuria glaberrima, Selenka.
Holothuria lubrica, Selenka.
Holothuria cinerascens (Brandt).
Holothuria atra, Jäger.
Holothuria edulis, Lesson.
Holothuria monacaria (Lesson).
Holothuria vagabunda, Selenka.
Holothuria fusco-cinerea, Jäger.
Holothuria fusco-rubra, Théel.
Holothuria pardalis, Selenka.
Holothuria maculata (Brandt).
Holothuria rugosa, Ludwig.
Holothuria discrepans, Semper.
Holothuria impatiens (Forskaal).

Holothuria scabra, Jäger.
Holothuria spinifera, Théel.
Holothuria ocellata, Jäger.
Holothuria martensii, Semper.
Holothuria albiventer, Semper.

Genus **HOLOTHURIA.** Linn. 1758.

Bohadschia, Jäger 1833.
Trepang, Jäger 1833 (*partim*).
Sporadipus, Brandt 1835.
Cystipus, Haacke 1880.

Usually 20 peltate tentacles, exceptionally more or less. Ambulacral appendages pedicels alone, papillæ alone or with both (pedicels on the trivium and papillæ on the bivium). Ambulacral appendages generally scattered, very rarely disposed in rows. As a rule the trivium is not clearly separated from the bivium. The anus is devoid of calcareous teeth. There is a single bundle of genital tubes on the left side of the dorsal mesentery. Tentacular ampullæ present. The calcareous ring without posterior prolongations and without long retractor muscles, stone canals often numerous ; respiratory trees well developed, the left branch being intimately connected with a *rete mirabile*. Cuvierian organs often present.

Holothuria hamata, n. sp.

(Plate V.; Plate VI., fig. 2.)

Two examples from Suez Bay, 5–9 fathoms, dredged by Mr. Cyril Crossland.

One of the specimens was narcotized in alcoholic sea water before preservation, and has retained more or less the proportions of the living animal. It is 225 mm. long and 54 mm. broad. The other specimen was put immediately with strong spirit and is greatly contracted.

External Characters.—After several years' immersion in strong spirit the animals have lost all colour, and are of a uniform yellowish-brown, slightly darker on the bivium than on the trivium. I have the advantage of some manuscript

notes of the species made by Mr. E. Hindle some years ago, when the spirit had evidently not extracted all the colour. He wrote as follows :—" Each dorsal papilla is light brown, surrounding this is a band of light gray, and finally there is an outer band of brown spots, marking off the light gray band from the brown background of the dorsal surface. This arrangement of bands of colour varies slightly, but every papilla on the dorsal surface shades off into a light gray, which is marked by a few brown spots. The ventral surface is light gray faintly marked by a few small light brown spots." Ambulacral appendages papillæ only, which are to some extent non-retractile. Those on the bivium are somewhat irregularly scattered, but nevertheless show an arrangement into four rows. Along each side of the body are 20 large claw-like outgrowths, which give the body a characteristic appearance. These processes increase in length towards the middle of the body, where they are 20 mm. in length. On the ventral surface there are two rows of broad papillæ, about 30 in each row.

There are 20 dark brown tentacles surrounded by papillæ.

Internal Anatomy.—There is one Polian vesicle on the ventral side and one stone canal on the right side of the dorsal mesentery. As in *Holothuria spinifera* and the related species, the stone canal is very large. Of the two respiratory trees the right is the longer, but the left more bulky. There are no Cuvierian organs.

Spicules.—Both the specimens examined by me have been preserved for some years, and the spicules show signs of disintegration. The spicules are very closely packed and consist of tables and buttons. The tables have usually a very irregular and indefinite shape, probably due to their having been partly dissolved. The most perfect form has a disc 100 μ in diameter, having a large central hole and about ten peripheral holes, and the tower is surmounted by numerous blunt spines reminding one very much of the tables of *H. aculeata*. The most common type, however, has fewer holes and the edge of the disc is spinous. The tower has four upright and one transverse beam. The buttons are knobbed and are extremely irregular in shape. They have an average length of 40 μ.

Remarks.—This form has affinities with *H. spinifera* and the related species. Nevertheless the large claw-like outgrowths on the sides of the body make the identification of this form easy. But the two specimens under examination are very different in external appearance, owing to the fact that one specimen has undergone great contraction.

Holothuria maculosa, n. sp.

(Plate VI., fig. 3.)

One specimen from Aldabra, near Île d'Esprit, collected by Mr. J. C. F. Fryer. 75 mm. long.

External Characters.—The specimen is evidently very much contracted owing to its preservation in spirit. Hence the body has a wrinkled appearance, and the ambulacral appendages are in a contracted condition. The ambulacral appendages consist of papillæ only, which are irregularly scattered over the whole body and show no arrangement with rows. The colour of the trivium is chocolate-brown with a yellowish-white circle 2 mm. in diameter around each papilla, thus producing a distinctly mottled appearance. The white patches seem to coalesce towards the posterior end of the body. The same contrast of colours is presented on the bivium, except that the brown is of a much darker shade, and is present along the middle of the back as a series of irregular patches which appear to be disposed in pairs. About five pairs of such markings are discernible, the smallest being about 8 mm. in diameter. In the same way the white does not confine itself to the papillæ, but in many places, especially towards the posterior end, there are large patches of white. Thus the bivium is not so regular in its markings as the trivium. There are five groups of papillæ around the anus. The tentacles are not present. The integument is very hard to the touch.

Internal Structure.—The calcareous ring is fairly large and the radials are massive. There is one long Polian vesicle and one small stone canal on the right side of the dorsal mesentery. The left respiratory tree is shorter but more voluminous, than the right. Cuvierian organs are present.

Spicules.—These consist of tables and buttons. The tables are somewhat irregular, the disc has a diameter of 66 μ, and the edge of the disc is uneven, and sometimes spiny. The disc is perforated by a varying number of holes up to twenty-four. There is no large central hole. The tower is very short and irregular, and in many instances there appears to be only an irregular spiny mass on the disc in place of a tower. Sometimes a short tower can be seen surmounted by a number of spines. The buttons are knobbed and irregular and have a length of about 45 μ. The typical number of holes is six, but there is great variation in this respect, as also in the irregularities of the surface. The papillæ are supported by tables and buttons similar to those in the general integument, and in addition there are perforated "cups" 20 μ in length, and elongated rods 75 μ in length, with perforations at the centre and the extremities. The papillæ have rudimentary terminal plates.

Remarks.—This species is evidently allied to *Holothuria aculeata*, Semper, both as regards its external appearance to some extent and also its internal structure. The tables, however, differ from those described by Semper. Semper describes his species as being uniformly yellowish-white on the trivium and darker on the bivium, the latter being irregularly streaked with dark brown; and this description agrees very closely with the colour of the specimen under examination.

Holothuria marmorata (Jäger).

(Plate VII., fig. 4.)

Bohadschia marmorata, Jäger 1833 (14).*
Sporadipus (*Colpochirota*) *ualenensis*, Brandt 1835 (8).
Holothuria ualensis, Selenka 1867 (37); Semper 1868 (38).
Holothuria brandtii, Selenka 1867 (37).
Holothuria marmorata, Semper 1868 (38); Ludwig 1881 (25), 1882 (26), 1888 (30); Lampert 1885 (19); Théel 1886 (42); Slinter 1887 (39), 1901 (41); Bell 1887 (5); Pearson 1903 (33), 1910 (34).

* The numbers in brackets refer to the literature at the end of the Paper.

Holothuria utrimquestigmosa, Haacke 1880 (12).

Several specimens, Trincomalee, Ceylon. Average length 150 mm. × 70 mm.

External Characters.—A massive species with a fairly thick body wall. It is almost cylindrical in shape, slightly flattened dorso-ventrally, and the two extremities are bluntly rounded. The mouth is ventral and the anus is terminal or slightly dorsal. The colour of the body is auburn-brown, and here and there on the bivium and the sides of the body are irregularly marked deep violet-coloured patches. The ambulacral appendages are surrounded by small dark patches. The trivium is but little lighter in colour than the bivium. The ambulacral appendages are true pedicels, those on the trivium being slightly larger than the rest. The pedicels are irregularly scattered and very numerous. The anus is more or less pentagonal and is guarded by five groups of papillæ. There are twenty light-coloured tentacles.

Internal Structure.—The calcareous ring is massive, but in the specimens I have examined I do not find that, as Théel states, the calcareous ring is larger than that of *H. argus*. On the contrary, I find that the latter species has a slightly larger calcareous ring. I am in agreement with Théel in finding a single large Polian vesicle and one stone canal. Lampert has recorded four, five, to seven Polian vesicles, and Koehler (15) has made a point of this difference of evidence, but it is well known that the number of Polian vesicles is a variable character. The right respiratory tree is larger than the left, and the Cuvierian organs arise from the base of the left respiratory tree.

Spicules.—These consist of a superficial layer of numerous small branched " rosettes " 15 μ in diameter. The species is characterized by also having small globular spicules 18 μ in diameter in the deeper layers of the dermis. The pedicles are supported by ordinary rosettes and small H-shaped spicules 26 μ in length.

Distribution.—Shallow water of the tropical zone of the Indo-Pacific region. My own observations show that this species has a peculiarly localized distribution in Ceylon. In Trincomalee it is exceptionally abundant, and I have brought

up as many as fifty specimens after five minutes' dredging from a small boat. On the western side of the Island it is apparently very rare, as I have not found a single specimen during a two-months' trawling and dredging expedition in the shallow-water region to the north of Colombo. Professor Herdman obtained only a single specimen during his visit in 1902.

Holothuria argus (Jäger).

(Plate VII., fig. 5.)

Bohadschia argus, Jäger 1833 (14) ; Bell 1889 (7).

Holothuria argus, Semper 1868 (38) ; Ludwig 1882 (26) ; Lampert 1885 (19), 1889 (20) ; Théel 1886 (42) ; Bell 1887 (6) ; Koehler 1895 (15) ; Sluiter 1901 (41).

One specimen from Ternate (Frankfürt Museum), 140 × 65 mm.

One specimen from Amboina (Geneva Museum), 295 × 70 mm.

External Characters.—Colour, yellowish-brown below and slightly darker above. The upper surface is characterized by the presence of numerous well-defined circles varying in diameter from 1 to 12 mm. In some cases several of these areas are joined up together, thus forming an irregular patch. The centre of each circle is occupied by a pedicel, the base of which is coloured dark brown ; towards the circumference the integument gradually changes from yellow to dark brown ; outside the circumference there is a light yellow area which gradually merges into the brown colour of the general integument. In addition to the pedicel in the centre of the circle, there are other ambulacral appendages irregularly arranged within the circle as well as on the general surface of the body.

The ambulacral appendages consist of pedicels. Those on the trivium have much better developed terminal discs. The pedicels are irregularly scattered and are extremely numerous, especially on the trivium. Some of the ambulacral appendages on the bivium are devoid of sucking discs and terminal plates.

The mouth is ventral and is surrounded by 20 tentacles. The anus is slightly dorsal. It is five-rayed, and surrounded by five groups of papillæ.

Internal Structure.—Internally this species resembles *H. marmorata*. The form of the calcareous ring is similar in both species. There is a single Polian vesicle and one stone canal. The right respiratory tree, which extends to the anterior end of the body, is larger than the left. The Cuvierian organs are not present in the specimen under examination, although they have been recorded from this species.

Spicules.—The deposits in the superficial integument are hardly to be distinguished from those of *H. marmorata*. The deposits in the deeper layers are, however, wanting in *H. argus*. The pedicels are supported by two kinds of spicules. First large rods generally perforated at both ends and 200 μ in length. There are also smaller irregular rods, often H-shaped, about 40 μ in length.

General Distribution.—Similar to that of *H. marmorata*. The latter species, however, is more abundant than *H. argus*.

Holothuria vitiensis, Semper.

(Plate VII., fig. 6.)

Holothuria vitiensis.—Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42); Sluiter 1901 (41).

Holothuria tenuissima.—Semper 1868 (38); Ludwig 1882 (26); Lampert 1885 (19); Théel 1886 (42); Sluiter 1887 (39), 1901 (41); Pearson 1903 (33); Koehler & Vaney 1908 (17).

Holothuria similis.—Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42).

Holothuria koellikeri.—Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42); Ludwig 1887 (28).

Holothuria clemens.—Ludwig 1875 (23); Lampert 1885 (19); Théel 1886 (42).

There appears to be no doubt that the five forms described under the five different specific names given above should really be included under the same name. This has previously been suggested by Théel (42), Koehler & Vaney (17), and the present writer (33), although Koehler & Vaney united only the four species *vitiensis*, *tenuissima*, *koellikeri*, and *clemens* under the name *H. tenuissima*. Since, however, *H. vitiensis* was first described, that name takes precedence of *tenuissima*. I have added the fifth species, *similis*, which does not appear to differ from the other four, except according to Semper (38) in the possession of true papillæ all over the body. This form has not been re-discovered since Semper first described it. Seeing that so many mistakes have been made in differentiating true pedicels and papillæ, and since the appendages of *marmorata*, *argus*, and *vitensis* show every gradation between true pedicels and undoubted papillæ, one is justified in regarding *similis* as being identical with *H. vitensis*.

There are three specimens in the present collections. One specimen was obtained by me recently on the Ceylon Pearl Banks, and I am therefore able to supply a description of the living animal.

External Characters.—The ambulacral appendages are pedicels, scattered amongst which are what appear to be true papillæ. In the living animal the colour of the bivium is light brown with numerous minute dark brown spots, which, when closely examined, prove to be brown rings around the bases of the pedicels. In addition there are about a dozen larger spots of a darker hue very irregularly disposed along each side of the bivium. These spots are, however, quite different from the circles of *H. argus*. The trivium is white, and the pedicels show up faintly owing to their being of a slightly darker colour. Along each side of the body some of the pedicels of the bivium are surrounded by yellow rings. The contrast between the bivium and trivium is well marked, not only on account of the differences of colour, but also owing to the presence of a slight longitudinal ridge along each side of the body. After the specimen was placed in spirit

this ridge was not clearly seen, but the colour differences between the two surfaces were accentuated, the bivium turning a chocolate-brown and the trivium a light yellow. Other spirit specimens examined by me, however, are light yellow all over the body, the pedicels being marked out by a light brown ring around the base of each. The bivium is well arched, and the trivium is flattened. The body-wall is extremely thin, and owing to the absence of pigment on the trivium the internal organs can be faintly seen. The anterior end of the body is rounded, but the posterior portion tapers considerably. The mouth is ventral and is surrounded by twenty light yellow tentacles, and the buccal ridge bears numerous small papillæ. The anus is thrown on to the dorsal surface and appears round in the preserved specimen. In the living animal the pulsating anus is alternately pentagonal and rounded. There are five groups of papillæ guarding the anus. The pedicels are irregularly scattered, and the sucking discs are apparently not well developed, since the living animal does not appear to use them much.

Internal Structure.—The calcareous ring is similar to those of the two previous species. A single Polian vesicle and one stone canal are present. The right respiratory tree is larger than the left, and Cuvierian organs are present.

Spicules.—The spicules in the general integument agree with those of the two previous species. As in *H. argus*, there are no deposits in the deeper layers of the dermis. The pedicels are strengthened by irregular rods and H-shaped spicules similar in size and shape to those of *H. argus*, but the larger rods described in the latter species are not present in *H. vitiensis*.

General Distribution.—This species has a similar distribution to that of *H. marmorata*.

Remarks.—Undoubtedly the three species *H. marmorata*, *H. argus*, and *H. vitiensis* are closely allied, and it is only with some difficulty that I am able to discover any differences of sufficient value to justify the separation of the three forms. The colour differences are fairly clear if their constancy can be proved I can vouch for the constancy of the colour of

H. marmorata found at Trincomalee, as I have examined hundreds of living specimens. The presence of a local race would, however, account for the constancy of this colour in the comparatively small area of Trincomalee Harbour. I cannot vouch for the constancy of the colour of the other two species, but I have not discovered any form having markings intermediate between the characteristic " circles " of *H. argus* and the irregular markings of *H. vitiensis*, nor has any other observer. An examination of the internal organs does not help much. It is true that I have found slight differences between the apparently similar calcareous rings of the three species, but I am quite prepared to find these differences break down upon an examination of a larger series. At first sight the spicules of the three forms are indistinguishable, but *H. marmorata* possesses calcareous grains in the deeper integument which are absent from the other two. This, then, clearly separates *H. marmorata* from *H. argus* and *H. vitiensis*. Sluiter (39) finds very little difference between the two latter species, except the thicker skin of *H. argus*. But apart from colour differences the pedicels show a difference in regard to the supporting spicules, *H. argus* having large supporting rods which are not present in *H. vitiensis*.

I give below a short key to distinguish the three species :—

A.—Small spherical spicules in the hypodermis.

..... *H. marmorata*.

B.—Spicules absent from the hypodermis—

(*a*) Dorsal surface conspicuously marked with circular patches. Spicules of pedicels, long bars with perforated ends 200 μ long, and smaller irregular often H-shaped spicules 40 μ long.

..... *H. argus*.

(*b*) Dorsal surface not possessing numerous circles. Spicules of pedicels consisting of rods 75 μ long and irregular H-shaped spicules 40 μ long.

..... *H. vitiensis*

Holothuria graffei, Semper.

(Plate VIII., fig. 7.)

Holothuria graffei, Semper 1868 (38) ; Ludwig 1882 (26) ; Lampert 1885 (19) ; Théel 1886 (42) ; Koehler 1896 (16) ; Sluiter 1901 (41).

Two specimens from Amboina (Geneva Museum), 180 mm. × 40 mm., 200 mm. × 45 mm. One specimen from Maldives (Gardiner), 140 mm. × 50 mm.

External Characters.—The ground colour is brown with numerous small dark spots scattered over the body. There are also some irregular dark brown patches on the bivium, chiefly around the papillæ. The ambulacral appendages consist of papillæ on the bivium and larger pedicels on the trivium. The pedicels are very large and are arranged in three well-defined rows, the middle row being broader than the two lateral ones and being about five or six pedicels thick in the middle of the body, but narrowing towards each end. The lateral rows are three pedicels thick at the middle of body and two towards each end. Near the anus the pedicels seem to give place to small papillæ which terminate near the edge of the anus. Anteriorly the pedicels stop at a distance of 20 mm. from the mouth. Near the anus the papillæ of the back appear to form two distinct rows, but very soon each row subdivides into three, so that along the greater part of the bivium there are about six irregular rows of papillæ. The mouth is surrounded by a rim of papillæ. There are 25 tentacles.

Internal Structure.—The calcareous ring is very large and is similar to that of *H. argus* and the related species. In the specimen dissected by me there were two Polian vesicles and a dozen stone canals, six on each side of the dorsal mesentery. The species appear to show considerable variation in regard to the number of stone canals and Polian vesicles. Cuvierian organs are present.

Spicules.—These consist of two kinds of bodies. First, there are numerous irregular fenestrated plates, and there are also irregular bodies which have been compared by previous

writers to imperfectly developed tables. They generally consist of two or three stout rods, sometimes trident-shaped, at other times like the tower of a typical Holothurian table. The speculations of previous writers as to the homology of these bodies with vestigial tables have little substantial support.

Remarks.—In the peculiar formation of the calcareous ring as well as in the general nature of the deposits this species shows relationship with *H. argus* and the allied species, from which, however, it differs in the abnormal number of its tentacles and in the arrangement of the ventral pedicels

General Distribution.—Indo-Pacific region.

Holothuria glaberrima, Selenka.

(Plate VIII., fig. 8.)

Holothuria glaberrima, Selenka 1867 (37) ; Semper 1868 (38) ; Lampert 1885 (19), 1896 (21) ; Théel 1886 (42) ; Ludwig 1887 (28) ; Clark 1901 (9) ; Koehler & Vaney 1908 (17).

Holothuria erinaceus, Semper 1868 (38) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria erinaceus, var. *pygmæa*, Semper 1868 (38) ; Lampert 1885 (19).

One specimen from Ternate (Frankfürt Museum).

Lampert (21) and Koehler & Vaney (17) have discussed the relationship of these forms and have thrown doubt upon Lampert's earlier opinion, with which Ludwig (31) agreed, that *Holothuria lubrica*, *Holothuria glaberrima*, *Holothuria erinaceus*, *Holothuria erinaceus* var. *pygmæa*, and *Holothuria parva* are identical. Although all these forms are undoubtedly related, I propose following Lampert and Koehler & Vaney in retaining *Holothuria lubrica* and *Holothuria parva* as distinct species, while including the remaining three under the name *glaberrima*.

External Characters.—The colour of the bivium is dark brown and the trivium is a lighter colour. There are twenty dark brown tentacles. On the bivium there are thinly-scattered papillæ of a small size and on the trivium there are

more numerous pedicels which are irregularly disposed. The anus is surrounded by a ring of papillæ.

Internal Structure.—Selenka speaks of the calcareous ring as being large, but in the specimen I have examined it is very small in comparison with most Holothurians. The allied form *Holothuria lubrica* has a large calcareous ring. There is a single Polian vesicle 4 mm. long and a large stone canal arising from the right side of the dorsal mesentery. This stone canal is over three times as long as the Polian vesicle. Cuvierian organs are present.

Spicules.—These consist of flattened plates, which in their complete state have a solid longitudinal axis bordered by numerous small holes. The holes along the course of the longitudinal axis frequently break down and produce perhaps the commonest type of spicules, which is a long rod having swollen ends which are perforated. All stages between these two extremes are seen. The spicules vary from 56 μ to 84 μ in length, with a mean length of 66 μ.

General Distribution.—This form has a world-wide distribution in tropical and sub-tropical waters, and is found in the Pacific, Indian, and Atlantic Oceans.

Holothuria lubrica, Selenka.

(Plate VIII., fig. 9.)

Holothuria lubrica, Selenka 1867 (37); Semper 1868 (38); Ludwig 1882 (26), 1887 (28), 1898 (31), 1899 (32); Lampert 1885 (19), 1896 (21); Théel 1886 (42); Sluiter 1901 (41); Koehler & Vaney 1908 (17).

I have one specimen, collected by Professor C. Ishikawa on Japanese waters. This is labelled *Holothuria lubrica* var. *moebii*, but it differs in no way from *Holothuria lubrica* and does not possess the essential characters of *Holothuria moebii*.

External Characters.—The spirit specimen measures 50 mm. in length and 20 mm. in breadth, but it is much contracted and wrinkled. It is with difficulty that the ambulacral appendages, consisting of pedicels below and papillæ above,

can be made out. The specimen is dark brown on the bivium and a lighter shade on the trivium.

Internal Structure.—Koehler & Vaney state that the calcareous ring is similar to that of *Holothuria glaberrima*. So far as the shape is concerned this is true, but the calcareous ring of *Holothuria lubrica* is much larger and more massive than that of the other species. There is a single Polian vesicle 12 mm. long and numerous stone canals, about eight on each side of the dorsal mesentery, having a mean length of about 5 mm. The specimen under examination has ejected its viscera, so that I cannot say whether Cuvierian organs are present or not. Ludwig is the only writer who records the presence of Cuvierian organs.

Spicules.—These consist of spinous rods varying in length from 112 μ to 148 μ, and having a mean length of 127 μ. The rods are often curved, and have fine spines along their length. The extremities are spinous and often perforated.

General Distribution.—Indo-Pacific region.

My examination of *Holothuria glaberrima* and the above species shows differences of three kinds :—(1) The large size of the calcareous ring of *lubrica* and the small size of that of *glaberrima ;* (2) the presence of numerous small stone canals on both sides of the dorsal mesentery in *H. lubrica* and the presence of only one extremely large stone canal in *H. glaberrima ;* (3) the nature of the spicules as described above.

Whether the first of these differences is constant, I cannot say. Selenka, however, states that the calcareous ring of *H. glaberrima* is large, whereas I find it very small. Koehler & Vaney also speak of the calcareous rings of the two species as being identical. In my specimens they are similar in shape but not in size.

The difference in the number and size of the stone canals may not appear to be a very important one, since it is well known that these organs are very variable ; but it is doubtful whether the variability is so great as shown by the specimens I have examined. Most of the records of the two species lend support to my emphasis of this difference. Nevertheless Ludwig (31) describes a specimen which had spicules like

H. glaberrima in which there were four stone canals, and another specimen which had spicules like *H. lubrica* but had only one long stone canal. These results are quite contrary to my observations.

Similarly there appears to be much variation in the size of the spicules of *H. glaberrima* and *H. lubrica*, and also according to Ludwig in regard to the shape of the deposits. In the specimens examined by me the spicules do not show intermediate stages linking up the two species. With regard to the size of the spicules my specimens of *H. glaberrima* show a length variation from 56 μ to 84 μ, with a mean length of 66 μ. The spicules of *H. lubrica* vary from 112 μ to 148 μ, with a mean length of 127 μ; that is to say, the spicules of the latter species are nearly twice as long as those of the former.

In Selenka's original description (37) he gave the length of the spicules of *H. glaberrima* as 50 μ and of *H. lubrica* as 60 μ. Lampert (21) gave the size of the spicules of the former species as 105 μ and of the latter as 70 μ, exactly the reverse of what I find. Hence the size of the spicules in the two species varies to a very large degree.

It is seen, then, that all three points of difference between the two species are dependent upon characters which have been shown to be inconstant, and it is possible that Ludwig's opinion that the two forms really belong to the same species may be eventually borne out when a sufficiently long series of specimens has been brought together for examination. In the meantime I follow Lampert and Koehler & Vaney in separating the two species.

Holothuria cinerascens (Brandt).

(Plate IX., fig. 10.)

Stichopus (*Gymnochirota*) *cinerascens*, Brandt 1835 (8).
Holothuria pulchella, Selenka 1867 (37); Semper 1868 (38); Haacke 1860 (12); Ludwig 1881 (25), 1883 (27); Théel 1886 (42); Sluiter 1887 (39); Bell 1887 (6).

Holothuria cinerascens, Lampert 1885 (19) ; Ludwig 1887 (28), 1897 (32) ; Sluiter 1901 (41) ; Bedford 1902 (3).
Holothuria willeyi, Bedford 1902 (3).

Several specimens from the Maldives (Gardiner), Seychelles (Dublin Museum), and Ceylon (various localities).

External Appearance.—Reddish-brown colour, lighter below and with some irregular dark patches above. The trivium is clearly separated from the bivium by reason of the disposition of the ambulacral appendages. Those on the trivium are pedicels which are closely arranged. There is sometimes a very narrow bare area in the mid-ventral line which separates the pedicles into two groups. The papillæ on the bivium are few in number and smaller in size than the pedicels, and are irregularly scattered. There are twenty large yellow tentacles.

Internal Structure.—The calcareous ring is large, the radial pieces being very well formed. In the specimens I have dissected there are two large Polian vesicles, one on the central radius of the trivium and one on the left radius of the bivium. There is a single stone canal on the right side of the dorsal mesentery. In this species both the Polian vesicles and stone canals vary in number to a considerable degree. The right respiratory tree extends to the anterior end of the body, but is very delicate. The left respiratory tree is much shorter, but more massive. Cuvierian organs are not present in the specimen examined by me, but they have been recorded in this species.

Spicules.—The deposits consist of small tables and spiny rods. The tables are intermediate between those of *H. atra* and *H. edulis*, but smaller. Sometimes the disc consists of a simple ring as in *H. edulis*, but in the more perfect condition it is more like that of *H. atra*. The diameter of the disc is 36 μ. The height of the table is about 40 μ, and it has a spiny top similar to that seen in *H. atra*. The spiny rods are similar to those of *H. lubrica*. They are slightly curved and are covered with very minute spines, which are larger at the two extremities. The rods are about 100 μ in length and 16 μ in width.

General Distribution.—Indo-Pacific region.

Remarks.—It would appear that this form is related to *Holothuria atra* and *Holothuria edulis* on the one hand and to *Holothuria lubrica* on the other. I cannot see any important differences between the above species and *Holothuria willeyi*, Bedford. In some specimens from Ceylon which I have examined the spicules vary from the type as Bedford's specimens did, but this variation appears to accompany the breaking up of the spicules. I consider Bedford's species properly belongs to *H. cinerascens.*

Holothuria atra, Jäger.

(Plate IX., fig. 11.)

Holothuria atra.—Jäger 1833 (14); Selenka 1867 (37); Semper 1868 (38); Ludwig 1881 (25), 1882 (26), 1887 (28) (29), 1899 (32); Lampert 1885 (19), 1896 (21); Théel 1886 (42); Bell 1887 (6), 1889 (7); Thurston 1890 (43); Koehler 1895 (15); Whitelegge 1897 (45), 1903 (46); Bedford 1898 (2), 1899 (3); Clark 1901 (9), 1902 (10); Voeltzkow 1902 (44), Pearson 1903 (33), 1910 (34); Fisher 1907 (11); Koehler & Vaney 1908 (17).

Holothuria amboinensis.—Jäger 1833 (14); Semper 1868 (38); Lampert 1885 (19).

Holothuria (*Microthele*) *affinis.*—Brandt 1835 (8).

Holothuria floridana, Pourtalès 1851; Selenka 1867 (37); Ludwig 1881 (25).

Holothuria atra var. *amboinensis.*—Théel 1886 (42); Bedford 1898 (2), 1899 (3).

Numerous specimens from every collection which I have examined. This is a very common species in the shallow waters of the Indo-Pacific.

In living specimens I have examined from the Ceylon Pearl Banks the colour was black or very dark brown or reddish-brown. The pedicels have white sucking discs, and the papillæ have white tips. The columns of the pedicels and papillæ are always black. Twenty dark brown or dark green tentacles.

There are small scattered papillæ on the bivium and more numerous and larger pedicels on the trivium, so that the two surfaces are clearly distinguished. In the living condition the back often appears almost smooth owing to the insignificant size of the papillæ. This species may attain a length of 350 mm., but it generally contracts to half its length when preserved.

Internal Structure.—The calcareous ring is of the usual aspidochirote type and is not very large. This form is interesting, because the number of Polian vesicles and stone canals varies in different individuals, the number generally being much higher than in most Holothurians. I have counted from one to five Polian vesicles and up to twenty-seven stone canals. The circum-œsophageal ring is some distance behind the calcareous ring. The right respiratory tree extends up to the calcareous ring, but is very delicate ; the left respiratory tree is shorter, but much more bulky. I have examined a great number of living specimens but have never seen any Cuvierian organs. The collected evidence goes to show that these organs are absent in the above species. In one specimen a small crab was found in the œsophagus at the level of the calcareous ring. Whether it had been taken in with the sand which passes through the alimentary canal, or whether it was living commensally, I cannot say.

Spicules.—The deposits of this well-known form consist of tables and somewhat irregular perforated plates. The tables are almost square in plan view and are 50 μ in diameter and 60 μ high, and generally consist of four large central holes with a small hole at each of the four corners. Occasionally, however, there may be an almost complete ring of small holes, and the edge of the disc may be spinous. The tower consists of four uprights joined by a transverse beam, and having four sets of well-developed spines on the summit. The perforated plates vary in shape and are not more than 25 μ in diameter.

Remarks.—The two forms of *H. atra* which Théel and Bedford regarded as distinct differ in respect of the spicules and colour. The one form, *H. atra* var. *amboinensis*, is black and has spines on the edges of the tables. The other, *H. atra*, is black but may have the papillæ and tube feet with whitish

ends, and the edges of tables are not usually spinous. Théel, however, has pointed out that *H. atra* sometimes has a spiny disc, and Bedford has shown that *amboinensis* may have no spines on the disc. The colour differences are apparently not constant, so that the distinctions between the two forms do not appear to be well defined.

H. pulla, Selenka, resembles *H. atra* in general appearance and in deposits, calcareous ring, and in the large number of the stone canals. But it has Cuvierian organs according to Théel, and it is this character alone which separates it from *H. atra*.

Distribution.—A shallow-water species, generally found within the 10-fathoms line and often between tide-marks. Principally Indo-Pacific, where it appears to be universally distributed between latitude 25° N. and 25° S. Also found in few places in West Indian area of Atlantic.

Holothuria edulis, Lesson.

(Plate IX., fig. 12.)

Holothuria edulis, Lesson 1830 (22); Semper 1868 (38); Ludwig 1882 (26), 1887 (29), 1888 (30), 1899 (32); Lampert 1885 (19); Théel 1886 (42); Sluiter 1901 (41); Koehler 1896 (15); Bedford 1899 (2); Koningsberger 1904 (18).

Trepang edulis, Jäger 1833 (14).

Holothuria fusco-cinerea, Selenka 1867 (37), (non Jäger).

Holothuria signata, Ludwig 1875 (23); Lampert 1885 (19), 1895 (21); Théel 1886 (42).

? Holothuria albida, Bell 1887 (5).

Numerous specimens from the various collections under examination. This is a very common Indo-Pacific littoral form, which is used as *beche-de-mer*.

External Characters.—I have been able to examine large numbers of living specimens from Ceylon, and they always have a very characteristic appearance. The ground colour of the skin is a bright rose-pink, which may be disguised by

varying degrees of black pigment. The black is very well marked on the bivium, where it varies from a grayish colour to an intense black, which at each side is gradually replaced by pink. The trivium is nearly always devoid of black. When preserved in spirit this species loses its pink colour and generally appears black above and gray below. There are pedicels on the trivium and papillæ on the bivium. The tube feet are readily distinguished, as each one is generally surrounded by a narrow black ring and has a white sucking disc. An arrangement into three rows is sometimes discernible. The papillæ are small and not very numerous. They are generally of the same colour as the general integument, so that they are not easily seen. There are twenty pinkish-white tentacles surrounded by a rim of small black papillæ. The anus is round and the diaphragm is black.

The living animal is long and narrow and may measure up to 400 mm. in length and 50 mm. in width. Spirit specimens are much shorter than this.

Internal Structure.—Internally this species differs but little from *Holothuria atra*. In both species the calcareous ring is similar, the Polian vesicles and stone canals are numerous and variable, and there are no Cuvierian organs present. The number of Polian vesicles varies from one to three, and the stone canals vary in number from 20 to 40, being disposed on each side of the dorsal mesentery. The circum-œsophageal ring is about 20 mm. behind the calcareous ring. Both right and left branches of the respiratory tree are large and of equal size.

Spicules.—These are similar to those of *Holothuria atra*, except that the disc of the tables is represented only by a ring.

Distribution.—Littoral waters of the Indo-Pacific region.

Remarks.—This species is undoubtedly related to *Holothuria atra*, but differs from the latter in the colour of the body and in the nature of the calcareous tables. I have had the opportunity of examining large numbers of this species on the Ceylon Pearl Banks, and have always found the pink colour to predominate over the black. At Trincomalee and Jaffna,

on the other hand, the pink colour was confined to a narrow strip on the middle of the trivium. The sides were gray and the middle of the bivium was black. Nevertheless there was no difficulty in distinguishing these dark-coloured specimens from *Holothuria atra*. On no occasion have I found any variation in the nature of the tables in the skin. I consider this species a good one, showing small but constant variations from *H. atra*.

Holothuria monacaria (Lesson).

(Plate X., fig. 13.)

Psolus monacaria, Lesson 1830 (22) ; Jäger 1833 (14).

Holothuria flammea, Quoy & Gaimard 1833 (36).

Holothuria fusco-punctata, Quoy & Gaimard 1833 (36).

Holothuria fasciola, Quoy & Gaimard 1833 (36).

Stichopus flammeus, Brandt 1835 (8).

Stichopus gyrifer, Selenka 1867 (37).

Labidodemas leucospilus, Haacke 1880 (12).

Holothuria monacaria, Lampert 1885 (19), 1889 (20), 1896 (21) ; Théel 1886 (42) ; Sluiter 1887 (39), 1901 (41) ; Ludwig 1887 (29), 1888 (30), 1899 (32) ; Koehler 1895 (15), (16) ; Bedford 1898 (2), 1899 (3) ; Pearson 1903 (33), 1910 (34) ; Fisher 1907 (11).

This species is well represented in the various collections under examination.

External Characters.—A well-marked form. There are papillæ on the bivium and pedicels on the trivium. The ground colour on the back is auburn, that on the trivium brown. The pedicels and papillæ are canary-yellow, and each one is surrounded by a light circular patch. Sometimes these light areas join up longitudinally so as to give a longitudinally striped appearance. The pedicels are slightly more crowded than the papillæ. Generally the pedicels are arranged in three double rows, but in some living specimens I have examined there was no such arrangement. The papillæ are arranged in about six more or less regular rows running along

the bivium. There are twenty light yellow tentacles. Around the base of the flattened head of each tentacle there is a row of small black spots. The mouth is surrounded by a ring of small papillæ, and there are five small groups of papillæ around the anus.

Internal Anatomy.—The internal organs call for no special mention. The calcareous ring is very small and the interradial pieces in particular are extremely delicate. There are one or two Polian vesicles and a single stone canal.

Spicules.—These consist of tables and buttons in the general integument. The tables have a base 65 μ in diameter perforated by a large central hole and about ten or a dozen small peripheral holes. The tower is 60 μ high and has one cross beam, and is surrounded by about eight irregular teeth. The buttons are 65 μ long and are smooth, and have three pairs of holes. There are irregular rods in the papillæ and fenestrated plates in the pedicels.

General Distribution.—A common form in the shallow waters of the tropical Indo-Pacific region.

So far as one can gather from Bell's scanty description and from the figures of the spicules given by him, *Holothuria macleari* would appear to be the same as *H. monacaria*, as Théel has suggested. Bell does not give the colour of his species, but his description of the arrangement of the pedicels and papillæ and the presence of white rings around them, together with the appearance of the deposits, would serve equally well as a description of *H. monacaria*. Further, he shows that the buttons are smooth, so that if reproduced correctly they cannot resemble those of *H. scabra* (*tigris*), as he suggests, since the latter species has knobbed buttons. This mistake is probably due to the incorrectness of Selenka's figure of the buttons of *H. scabra*.

I have before me a single specimen from the collection of the late Professor Mitsukuri of Tokyo, labelled *H. macleari*, but I have not the slightest hesitation in assigning this specimen to *H. monacaria*, both on account of the external appearance and general characters, and also because of the nature of the deposits.

Holothuria vagabunda, Selenka.

(Plate X., fig. 14.)

Stichopus (*Gymnochirota*) *leucospilota*, Brandt 1835 (8).

Holothuria vagabunda, Selenka 1867 (37) ; Semper 1868 (38) ; Ludwig 1875 (23), 1882 (26), 1883 (27), 1887 (29), 1888 (30), 1881 (25), 1899 (32) ; Lampert 1885 (19) ; Théel 1886 (42) ; Bell 1889 (7) ; Koehler 1895 (15), (16) ; Whitelegge 1896 (45) ; Bedford 1898 (2), 1902 (3) ; Sluiter 1901 (41) ; Pearson 1903 (33), 1910 (34) ; Koningsberger 1904 (18) ; Fisher 1907 (11) ; Koehler & Vaney 1908 (17).

Numerous specimens from most of the collections under examination.

A very common littoral species of the Indo-Pacific littoral waters.

External Characters.—The body is dark brown, the ambulacral appendages black tipped with white, and the tentacles are greenish-brown or dark brown. Ambulacral appendages are papillæ on the bivium and pedicels on the trivium. Some of the earlier writers state that true pedicels only are present on the bivium. The dorsal appendages, although elongated, have no sucking discs, and may therefore be regarded as papillæ. The long fine papillæ are numerous and can be extended to a length of 7 mm. They are tipped with white and show no arrangement with rows. Owing to their length they give the living specimen a somewhat ragged appearance. The pedicels of the trivium are still more numerous, but show no arrangement into rows. They are terminated by white sucking discs. Twenty tentacles are present, surrounded by a rim of black papillæ. The anus is round. Living specimens may measure up to 380 mm. in length and 65 mm. in width.

Internal Structure.—The calcareous ring is normal. Usually there is one Polian vesicle and one stone canal present. The respiratory trees are well developed. Cuvierian organs are present, and in the living specimen have a purplish colour.

Deposits consist of tables and buttons. The tables have a disc 50 μ in diameter. In young specimens the disc is

perforated by ten or a dozen holes, but in older specimens there are generally only four peripheral holes. The tower is 35 μ high and consists of four uprights connected by one cross beam, and is terminated by a ring bearing eight or ten spines. The buttons are 50 μ in length and have three pairs of holes. There are also perforated plates in pedicels and irregular spinous or perforated supporting rods in the papillæ.

General Distribution.—A common Indo-Pacific form.

Remarks.—Although this species should, strictly speaking, be named *leucospilota*, the name *vagabunda* is in such universal use, that the demands of priority should be waived. This has evidently been the view of every writer since Ludwig showed in 1875 that *Stichopus leucospilota*, Brandt, is identical with *Holothuria vagabunda*, Selenka. At any rate no one has used the rightful name, and I see no reason to adopt a different course.

In 1886 Théel suggested that *H. vagabunda* and *H. lagæna* were identical, and in 1895 Koehler (16), after an examination of specimens from different localities, proposed to unite the two, but in 1908 Koehler & Vaney did not give *H. lagæna* as a synonym of the species, so that one is led to conclude that Koehler did not maintain his earlier view. I have had no opportunity of examining a specimen agreeing with *H. lagæna*, so that I am unable to throw any light upon the question.

Holothuria fusco-cinerea, Jäger.

(Plate X., fig. 15.)

Holothuria fusco-cinerea, Jäger 1833 (14); Lampert 1885 (19); Théel 1886 (42); Ludwig 1882 (26), 1887 (29); Sluiter 1887 (39).

Holothuria pervicax, Selenka 1867 (37); Ludwig 1897 (32); Sluiter 1901 (41); Fisher 1907 (11).

Holothuria depressa, Ludwig 1875 (23); Lampert 1895 (21).

Holothuria mammiculata, Haacke 1880 (12).

Holothuria fusco-cinerea var. *pervicax*, Bedford 1898 (2).

Holothuria dofleinii, Augustin 1908 (1); Pearson 1910 (34).

There are about twenty specimens in the collections under examination.

External Characters.—There is a distinct separation of the bivium from the trivium, the latter bearing pedicels only, and the former papillæ. The general ground colour of the spirit specimens is grayish-yellow. The pedicels, which do not show any arrangement into rows, are brown-coloured with yellow sucking discs. Each pedicel is surrounded by a white ring. On the bivium the papillæ are situated on the summits of warts of various sizes, the largest being arranged in two rather irregular rows near the middle of the back. There are about six in each row, and each of these is surrounded by a broad bluish-black area, which joins with the dark area around the corresponding papillæ of the other row to form a transverse band. There are about six of these bands. In some cases the dark area in question is separated from the papilla by a light ring, as described by Augustin (1). The smaller papillæ are arranged irregularly, although there is a slight suggestion of an arrangement into rows, especially near the junction of the bivium and trivium. Most of these small papillæ are dark-coloured and are surrounded by a light ring. The tentacles were not seen in any of the specimens.

Internal Structure.—The calcareous ring is typical of the genus. There is a single stone canal on the right side of the dorsal mesentery, and there is a single Polian vesicle. The left respiratory tree is larger than the right, and Cuvierian organs arise from the base of the left respiratory tree. In the specimens examined the gonads were well developed and extended to the posterior end of the body.

Spicules.—The calcareous deposits consist of tables and buttons. The tables have a disc 40 μ in diameter, generally consisting of four larger central holes and alternating with these four smaller peripheral holes. The spire is generally imperfectly formed and has no definite shape. It may consist of three or four uprights which do not join at their summit, or there may be two irregular uprights diverging towards the summit, where they are connected by an irregular cross beam. These tables are hardly to be distinguished from those of *H. curiosa*. The buttons consist of a central axis, from which are given off from three to six irregular outgrowths at each side, and are about 20 μ in length. They remind one strongly of

the buttons of a typical Holothurian, in which the outer walls bounding the holes of the buttons have been broken down. Nevertheless the perfect button is very rarely found in this species. These buttons differ from those of *H. curiosa*.

General Distribution. — The Indo-Pacific region. Not very common.

Remarks.—The specimens which I have under examination differ in no respect from those described by me in 1910 (34), and which I identified as *H. dofleinii*, Augustin. On further examination I believe that this species is identical with *H. fusco-cinerea*, Jäger, and *H. pervicax*, Selenka. I consider that Augustin's grounds for not including his specimens under *H. fusco-cinerea* are insufficient. The two reasons for his not doing so are the presence of white rings around the papillæ in his specimens and the character of the buttons. With regard to the first of these, I have before me sufficient material to state that the colour of the rings around the papillæ varies to a considerable degree. As for the spicules I cannot see any difference of sufficient importance to justify Augustin's new species.

There is no doubt that Semper's *Holothuria fusco-cinerea* is identical with *H. curiosa*, Ludwig, and not with Jäger's species, although *H. fusco-cinerea*, Jäger, and *H. curiosa*, Ludwig, are undoubtedly closely related. But I do not agree with Bedford and Théel that *H. curiosa* should be included in *H. fusco-cinerea*, Jäger, since the colour markings and the buttons are different in the two forms. Ludwig (23) describes his *H. depressa* as having a grayish-brown colour and three or four transverse brownish marks ; on the trivium the pedicels were numerous, and on the bivium the papillæ were sparsely scattered and situated upon wart-like elevations, the tips of which had a dark colour. The pedicels of the trivium were each surrounded by a light ring.

Selenka's (37) short diagnosis and Fisher's (11) exhaustive description of *Holothuria pervicax* agree with the account of *H. fusco-cinerea* which I have given above.

I cannot agree with Bedford that *H. argus* is allied to this form. In external appearance, in the nature of the spicules and calcareous ring, that species differs greatly from *H. fusco-cinerea*

Holothuria fusco-rubra, Théel.

(Plate XI., fig. 16.)

Holothuria fusco-rubra, Théel 1886 (42); Sluiter 1901 (41); Fisher 1907 (11).

A few specimens are found in the collections under examination.

External Characters.—Body is robust, and is covered with numerous well-formed pedicels on the trivium and less numerous papillæ on the bivium. There are five groups of papillæ around the anus. There are twenty tentacles. The body is purplish-brown in alcohol. This colour is seen in the sections of the integument which it is customary to prepare for the microscopical examination of the spicules.

Internal Structure.—In the specimen examined by me the calcareous ring is slightly different from that figured by Théel. There are two Polian vesicles and a single stone canal. The left respiratory tree is more bulky than the right, but does not extend so far forward. Théel and Fisher stated that the species possesses Cuvierian organs, but they are not present in the specimen under examination.

Spicules.—These consist of tables and buttons. The disc tables vary in size according to the state of their development. The largest tables are 55 μ in diameter, and have four central holes and a ring of smaller peripheral holes. The edge of the disc is spiny. The tables are reduced or absent. Frequently the disc is reduced and possesses no peripheral holes, and then has the appearance of the reduced disc of *H. pardalis.* The buttons are irregular. In their most regular form they have three pairs of holes and are about 65 μ long. Frequently some of the holes are missing, and these asymmetrical forms are the commonest. The pedicels are supported by long irregular buttons having several pairs of holes. The papillæ are supported by irregular branched rods.

Distribution.—Indo-Pacific. Not very common.

Holothuria pardalis, Selenka.

(Plate XI., fig. 17.)

Holothuria pardalis, Selenka 1867 (37) ; Semper 1868 (38) ; Ludwig 1880 (24), 1882 (26), 1883 (27), 1887 (28), (29), 1888 (31), 1899 (32) ; Bell 1884 (4) ; Lampert 1885 (19), 1889 (20), 1895 (21) ; Théel 1886 (42) ; Sluiter 1887 (39), 1901 (41) ; Herouard 1893 (13) ; Koehler 1895 (15), (16) ; Whitelegge 1817 (45) ; Bedford 1898 (2) ; Voeltzkow 1902 (44) ; Fisher 1905 (11) ; Koehler & Vaney 1908 (17).

Holothuria subdivita, Selenka 1867 (37) ; Semper 1868 (38) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria insignis, Ludwig 1875 (23), 1883 (27) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria lineata, Ludwig 1875 (23), 1880 (24), 1882 (26), 1883 (27) ; Bell 1884 (4) ; Lampert 1885 (19) ; Théel 1886 (42) ; Pearson 1910 (34).

Holothuria peregrina, Ludwig 1875 (23) ; Bell 1884 (4) ; Lampert 1885 (19) ; Théel 1886 (42).

Holothuria pardalis var. *insignis*, Sluiter 1890 (40) ; Bedford 1899 (3).

This is a very widely spread species, and well represented in the various collections I have had the opportunity of examining.

Owing to this species being subject to considerable variation, both in colour and in the form of the spicules, much confusion has arisen with regard to its identity, and consequently the synonymy is somewhat intricate.

External Appearance.—The colour is yellowish-brown above and lighter below. Along the bivium there are frequently from five to ten pairs of dark brown patches, which give the species a characteristic appearance. Occasionally, however, these patches are wanting. The ambulacral appendages appear to be all true pedicels, which are not arranged in rows. Those on the trivium are more abundant than those on the bivium and are slightly larger. There is a circle of small papillæ around the anus. There are twenty small tentacles. Fisher (11) says the number is variable.

Internal Structure.—The calcareous ring is very small and presents no points of interest. There are one or two long, fine, Polian vesicles. The stone canal is evidently very small, as I have been unable to determine its presence in several specimens. Other observers have noted the presence of one or two stone canals. The left respiratory tree is more bulky than the right, but not so long. There are no Cuvierian organs.

Spicules.—These consist of tables and buttons. The tables when fully developed have a disc 60 μ in diameter, consisting of a central hole apparently divided into four when seen from below, owing to the presence of the four beams of the tower. There are also about eight smaller peripheral holes. The edge of the disc is slightly irregular, as though suggesting the presence of still another circle of holes in perfect condition, although in some specimens the edge is quite smooth, as in *H. bowensis*. When seen in side view the edge of the disc turns up slightly. The tower is generally short, and consists of four uprights connected by a single cross beam. Occasionally a fairly tall tower is seen. The top of the tower is square and bears a few blunt spines. The type of table described above is, however, rarely seen in the adult. The common form has a disc with an irregular edge, in which the outer circle of holes has broken down, leaving either only four holes, one at each corner, or no peripheral holes, or even no holes at all. In such tables the tower is frequently reduced and may be absent altogether. The buttons are very irregular. Typically they are smooth buttons with three or four pairs of holes. Often, however, some of the holes are missing, and thus the characteristically asymmetrical appearance is produced. Often the buttons are slightly twisted when seen in side view.

The buttons are usually arranged in groups or circles, but in many of the specimens I have examined this arrangement is not very clear, due probably to the contraction of the integument. The pedicels are supported by robust curved rods, which are perforated at each end. There appear to be two distinct types of spicules, as Fisher (11) states. In some specimens the tables are large and well developed, and the buttons frequently have four holes. In the majority of specimens, however, the tables are reduced and the buttons are very irregular.

Distribution.—A very common form in the Indo-Pacific tropical and sub-tropical littoral waters.

Remarks.—This species is related to *H. fusco-rubra* and *H. curiosa*.

Holothuria maculata (Brandt).

(Plate XI., fig. 18.)

Sporadipus (*Acolpos*) *maculata*, Brandt 1835 (8).

Holothuria arenicola, Semper 1868 (38) ; Théel 1886 (42) ; Sluiter 1887 (39) ; Fisher 1907 (11).

Holothuria maculata, Ludwig 1881 (25), 1883 (27), 1887 (28), 1888 (30), 1897 (32) ; Lampert 1885 (19), 1895 (21) ; Bedford 1898 (2), 1899 (3) ; Sluiter 1901 (41) ; Clark 1902 (10) ; Koningsberger 1904 (18) ; Koehler & Vaney 1908 (17).

There are numerous specimens of this species in the collections under examination.

External Characters.—The ground colour of the body is yellowish-white or pinkish-white ; on the trivium there are a few scattered small brown spots. On the bivium there are two rows of dark brown patches, varying from six to fifteen in each row in different specimens. Occasionally these markings are absent altogether. There are twenty small tentacles. The ambulacral appendages are similar all over the body, and are apparently true pedicels, as they have well-developed sucking discs. These appendages are irregularly scattered, and appear to be equally abundant on the trivium and bivium. The anus is pentagonal and is surrounded by five groups of papillæ.

Internal Structure.—The calcareous ring is well developed. There is generally a single small Polian vesicle and small stone canal present. In a specimen examined by Théel there were two Polian vesicles and a bundle of three stone canals on the right side of the dorsal mesentery. No Cuvierian organs are present in any of the specimens examined by me, but their presence has been recorded by previous writers. The

respiratory trees are well developed, that on the right side being longer than the left, but not so large.

Spicules.—In the general integument there are tables and smooth buttons. The tables have a disc 60 μ in diameter, which has four large central holes and a varying number of peripheral holes. The tower is of the ordinary type and is surrounded by numerous spines, and is 42 μ high. The buttons have three pairs of holes and are 50 μ long. They are extremely thick. The supporting rods of the pedicels are curved rods 100 μ in length, and have perforated enlargements at each end and in the middle.

Distribution.—Tropical waters of the Indo-Pacific region.

Remarks.—Fisher (11) has pointed out that the name *maculata*, which is generally given to this species, must give place to *arenicola*, since the former name was given to a species of the same genus by Chamisso & Eysenhardt in 1821. But this species, which was first named *Holothuria maculata* in 1821, and later on *Fistularia maculata* in 1834, is now known as *Synapta maculata*. The species under discussion, on the other hand, was first described in 1835 under the name *Sporadipus maculatus*, a designation which is not invalidated by any of the synonyms of *Synapta maculata*. *Holothuria maculata* was first given its present name by Ludwig (25) in 1881, when the Synaptid was no longer placed in the genus Holothuria.

Nevertheless a species described by Lesseur in 1824 had already been named *H. maculata*, a name which strictly should still stand. Since, however, Lesseur's description is too imperfect for purposes of identification, and since, moreover, the name *maculata* has been given to the species under discussion by most authors of recent years, the name has become established, and I do not propose to use Semper's synonym *arenicola* in place of the now almost universally accepted name *maculata*.

Five specimens of this species collected by Mr. Cyril Crossland at Suez, differ somewhat from the recognized form. The two rows of dark patches are absent from the bivium, but at each extremity there is a well-defined area in which the ground colour is black and the appendages are light yellow. The

general colour is auburn; and the appendages appear to be more numerous and larger than in typical specimens. Internally they show no points of interest. The deposits differ slightly from typical forms in that the disc of the table is frequently much reduced and the holes of the buttons are extremely small.

Holothuria maculata burrows in the sand between tide-marks.

Holothuria rugosa, Ludwig.

(Plate XII., fig. 19.)

Holothuria rugosa, Ludwig 1875 (23), 1882 (26); Lampert 1885 (19); Théel 1886 (42); Bedford 1898 (2); Koehler & Vaney 1908 (7).

? Holothuria triremis, Sluiter 1901 (41).

One specimen, obtained by Mr. J. Stanley Gardiner in the Maldives.

External Characters.—Length 85 mm., breadth 20 mm. The colour in spirit is yellowish-brown. There are papillæ on the bivium and true pedicels on the trivium. In the specimen examined by me all the papillæ are closely retracted, but the pedicels are still half expanded. The pedicels are arranged in three distinct rows on the trivium. The central row is clearly double, and the lateral rows are single, although in some parts, probably owing to contraction, the lateral rows are zig-zag and thus appear double. A close inspection with a lens shows that the papillæ are arranged in six irregular rows on the bivium, but with the naked eye very few papillæ can be seen.

Internal Structure.—The calcareous ring agrees with Ludwig's drawings of the species, and it also resembles that of *Mesothuria murrayi*, Théel, a resemblance which is also seen in the case of the spicules. But *Mesothuria murrayi* differs in many respects from the above species, and is undoubtedly not identical with it. The tentacles are absent in the specimen from the Maldives, as are also the principal internal organs.

Spicules.—The deposits consist of tables and buttons. The tables consist of a disc 90 μ in diameter consisting of a central hole and a dozen or more peripheral holes. In the most complete form the tables bear long spines on the edge of the disc. There is a well-developed tower having a height of 65 μ, and consisting generally of four uprights which converge towards the summit of the tower, and which are joined together by a cross-piece. These supports bear spines about half-way up. The top of the tower bears a number of long spines, some of them 50 μ in length, which radiate outwards from the centre. Many of the tables show signs of disintegration. Frequently the spines on the outside of the disc and on the top of the tower are either absent or very much reduced, and sometimes the disc is so much reduced that instead of a circle of holes there is merely a serrated border.

In the Maldives specimen the buttons are extremely scarce, and are apparently only present in and about the pedicels and papillæ, but in a specimen from the Indian Museum the buttons are evenly scattered. It is possible that the buttons, which are extremely delicate, have been dissolved out of the Maldives specimen through the action of formalin, since most of the tables are much reduced. The buttons are irregular, and generally have four or more pairs of holes, but the buttons are frequently asymmetrical in regard to the number of holes.

Remarks.—So far as I can judge from the descriptions it would appear that *H. triremis*, Sluiter (46), is identical with Ludwig's species, although there are some differences in the two accounts. The Maldives specimen appears to link up Ludwig's and Sluiter's specimens. Ludwig's single specimen was light yellow, and had twenty yellow tentacles. The body was marked by five radial ridges and by several transverse wrinkles, probably due to ante-mortem contractions. The trivium bore numerous pedicels and the bivium less numerous papillæ. Sluiter's specimens were reddish-brown colour and had twenty brownish-voilet tentacles. The pedicels were arranged in three distinct double rows on the trivium, and the numerous papillæ stood on conical warts and were irregularly arranged. It is with regard to the spicules that the two

species show great similarity, and they agree in the main with the description I have given above.

Sluiter's figure of the tables differs from Ludwig's, in that the supports of the spire are parallel. In Ludwig's they converge as they approach the summit, and there are sometimes six supports. Ludwig's specimen had the buttons aggregated around the pedicels and papillæ. In Sluiter's they appear to be evenly distributed.

In the specimen which I have before me the external characters agree more with Sluiter's species, since the tube feet are arranged in three distinct rows, but it resembles Ludwig's specimen in the form of the calcareous ring and the deposits.

General Distribution.—An uncommon form, confined to the Indo-Pacific littoral regions.

Holothuria discrepans, Semper.

(Plate XII., fig. 20.)

Holothuria discrepans, Semper 1868 (38); Lampert 1885 (19); Théel 1886 (42).

One specimen, obtained by Professor J. Stanley Gardiner in the Maldives. The specimen is very small, being only 20 mm. long. The only other specimens known are two described by Semper (38) from Samoa.

External Characters.—The colour of the small spirit specimen is yellow below. On the bivium there are a few yellow circles around the papillæ and there are several narrow bluish-black transverse bands across the bivium. The trivium bears yellow pedicels which are arranged in three distinct rows, the two outer rows being double and the central row having four sets of pedicels. Semper does not describe the arrangement of the tube-feet. It is possible that in this species, as in many others, the tube-feet are arranged in rows in the young specimens only. There are a few papillæ irregularly scattered over the bivium. According to Semper there are thirty tentacles. Owing to the minute size of the specimen under examination I cannot confirm this.

Internal Structure.—The calcareous ring is of the usual type. I am unable to detect the Polian vesicle and stone canal, but Semper describes the presence of the Polian vesicle and one stone canal. Cuvierian organs are present.

Spicules.—These consist of tables in the general integument, and according to Semper smooth buttons with three pairs of holes around the base of the ambulacral appendages. There are also elongated perforated plates supporting the appendages. The tables measure 44 μ across the disc. The disc has typically a large cross-shaped hole in the centre, four parts of which reach the periphery, and alternating with these are four smaller holes. The disc is subject to variation in regard to this. When the tower is complete, which is rare, it is surmounted by a square top which bears several spines, the four largest being placed one at each corner. The tower is low, being only about 25 μ in height, and seems to have a variable number of supports. The perforated supporting rods of pedicels are 80 μ or more in length. They are very broad in the middle and bulge slightly at each end.

Distribution.—Samoa and Maldives. Only three specimens of this species are known. The first two were described from Samoa in 1868, and the other specimen was not obtained until thirty years later from the Maldives. Considering the great distance between these two localities it is surprising that no specimens have been recorded from intermediate stations during a period of thirty years.

Holothuria impatiens (Forskaal).

(Plate XIII., fig. 21.)

Fistularia impatiens, Forskaal 1775.
Trepang impatiens, Jäger 1833 (14).
Holothuria fulva, Quoy & Gaimard 1833 (36).
Thyone impatiens, Blainville 1834.
Sporadipus impatiens, Grube 1840.
Holothuria botellus, Selenka 1867 (37); Semper 1868 (38).

Holothuria impatiens, Semper 1868 (38) ; Ludwig 1875 (23), 1887 (29), 1888 (30), 1899 (32) ; Lampert 1885 (19), 1889 (20), 1896 (21) ; Théel 1886 (42) ; Bell 1887 (6), 1889 (7) ; Sluiter 1887 (39), 1910 (41) ; Herouard 1893 (13) ; Koehler 1895 (15) ; Bedford 1899 (3) ; Koningsberger 1904 (18) ; Fisher 1907 (11) ; Koehler & Vaney 1908 (17) ; Pearson 1910 (34) (35).

External Appearance.—The body is covered with papillæ only, no true pedicels being present. These are situated upon conical eminences, which give a characteristically papillated appearance to the body. The papillæ are irregularly disposed, and appear to be equally abundant upon the bivium and trivium. The colour of the body is brown, punctated with numerous minute dark brown spots. Some of the dorsal papillæ are dark brown, others a light brown. There is often a series of purplish-brown transverse stripes across the back, those in front being regular, but becoming more irregular towards the posterior end of the body. Thus the back of the animal presents a variegated appearance. The body when extended is very long in proportion to its width, and in a living example measured by me the length was 275 mm. and the width 25 mm. There are 20 light yellow tentacles, and the anus is surrounded by a rim of small papillæ.

Internal Structure.—The internal structure calls for no special remarks. The Cuvierian organs are double, and extremely large. The left respiratory tree extends to the anterior end of the body, but is extremely slender ; the right respiratory tree, on the other hand, is short but massive.

Spicules.—The calcareous deposits consist of tables and smooth buttons. The tables are characteristic, and consist of a fairly square base, consisting of nine almost equal holes forming rows of three. The base has a diameter of 90 μ. The tables are 75 μ high and generally have one cross-beam, but there may exceptionally be two. The tower is surmounted by about 20 spines. The buttons are 75 μ in length and have six holes.

General Distribution.—This is a common form in the tropical and sub-tropical waters of the Indo-Pacific region. It has also been recorded from Florida.

Holothuria scabra, Jäger.

(Plate XIII., fig. 22.)

Holothuria scabra, Jäger 1833 (14); Brandt 1835 (8); Semper 1868 (38); Haacke 1880 (12); Ludwig 1882 (26), 1883 (27); Lampert 1885 (19); Théel 1886 (42); Sluiter 1901 (41); Koningsberger 1904 (18); Koehler & Vaney 1908 (17); Pearson 1910 (34), 1910 (35).

Holothuria tigris, Selenka 1867 (37).

Holothuria cadelli, Bell 1887 (5).

Holothuria gallensis, Pearson 1903 (33).

There are numerous specimens in the collections under examination.

External Characters.—The body is comparatively short and stout. The two ends are flattened. The body is covered with minute papillæ, which are irregularly scattered and are more abundant on the trivium than on the bivium. This species probably shows greater colour-variation than any other Holothurian. The bivium may be black, black with a few yellowish-white streaks, or black with broad transverse white bands. The black may vary in intensity, and is frequently replaced by gray. The trivium is of a light yellow colour, so that there is a marked distinction between the two surfaces. On the yellow ground may be seen numerous small gray patches, which mark the position of the papillæ. Each papilla is grayish in colour and surrounded by a gray circle. In the extreme cases the gray patches join together to form an irregular mass, broken up by lighter markings. There are twenty tentacles.

Internal Structure.—The calcareous ring is normal. The Polian vesicles vary in number. In one freshly-killed specimen, 225 mm. long, there were three Polian vesicles. The first was 40 mm. long and arose in the left inter-radius of the trivium. The second was 15 mm. long and arose on the left radius of the bivium. The third was 110 mm. long and arose near the dorsal mesentery. The single stone canal is small and

sometimes difficult to find. In the specimen referred to above the stone canal was situated close to the third Polian vesicle. The left respiratory tree is larger than the right, but does not extend so far forward as the latter. No Cuvierian organs are present.

Spicules.—The spicules consist of tables and knobbed buttons. The tables are 72 μ in diameter, and have a large central hole and several smaller peripheral holes. The margin of the disc is smooth. The tower is 50 μ high and is robust. Its four uprights are connected by one tier of cross-beams, and the top is surmounted by numerous spines.

The buttons have three pairs of holes and are 50 μ long.

Holothuria spinifera, Théel.

(Plate XIII., fig. 23.)

Holothuria spinifera, Théel 1886 (42) ; Ludwig 1887 (29).

Only two specimens of this species have been recorded hitherto, the type of the species which was obtained by the "Challenger," near the Philippine Islands, and one specimen obtained by the Drs. Sarasin on the East Coast of Ceylon. The Colombo Museum possesses three more specimens, two of which were obtained from the Ceylon Pearl Banks by the present writer, and another without a label. One specimen measured when in an expanded condition was 350 mm. long and 65 mm. broad.

External Characters.—The body is yellowish-white on the trivium, with the exception of a light brown streak which runs longitudinally along the medium line. The dorsal surface is light brown, darker in the middle, and becoming lighter at each side. Some of the dorsal papillæ are also dark brown in colour. The ambulacral appendages are papillæ only. They are scattered irregularly over the body, those on the dorsal surface being bigger and more conical. Along each side of the body at the junction of the bivium and trivium there is a row of papillæ slightly larger than those on the back. The bivium

is well arched and the trivium is flattened. There are five groups of papillæ around the anus. There are twenty light yellow tentacles. The tentacles are surrounded by a rim of small papillæ.

Internal Structure.—The calcareous ring presents no features of importance. There is a single Polian vesicle 25 mm. long when contracted. The single stone canal is situated on the right side of the dorsal mesentery. As Théel has pointed out, it is of extraordinary length, being 35 mm. long in the specimen of which the measurements are given above. The right respiratory tree is larger than the left. In the specimens examined by me there are no Cuvierian organs.

Deposits.—These agree generally with Théel's description. They consist of tables and knobbed buttons in the general integument. The disc of the table is rounded and has a diameter of 90 μ, and is perforated irregularly by a number of small holes. Sometimes there is a central hole surrounded by a number of peripheral holes. The under surface of the disc is not always smooth, but is sometimes complicated by the presence of irregular cross-connections. The tower is 60 μ in height, and has one cross-piece, and is surmounted by a large number of spines.

The buttons are 40 μ long and have three pairs of holes, and often show irregularities.

In the papillæ there are tables with very high towers (300 μ high) ending in a single blunt spine, and also irregular perforated plates. The high towers make the identification of this species clear.

General Distribution.—Philippines, Ceylon.

Holothuria ocellata, Jäger.

(Plate XIV., fig. 24.)

Holothuria ocellata, Jäger 1833 (14); Lampert 1885 (19); Théel 1886 (42); Koehler & Vaney 1908 (17); Pearson 1910 (35).

One specimen from the Indian Museum, length 120 mm., breadth 55 mm.

External Appearance.—The spirit specimen has a yellowish-white ground colour. Numerous small brown spots are scattered over the integument, but they are too small to detect without the aid of a hand lens, except in the middle of the trivium and irregularly on the bivium, where they are much more crowded and produce brown markings. Most of the papillæ on the bivium are of a chocolate-brown colour, thus standing well out upon the lighter background. I cannot see the double circular ring around the papillæ which Théel described. The ambulacral appendages consist of papillæ only, which, as in *Holothuria spinifera*, remain extended to a considerable extent in the preserved specimen. The papillæ are slightly smaller and more numerous on the trivium. The largest papillæ are found along each side of the body, as in *Holothuria spinifera*.

Internal Structure.—The calcareous ring is well formed and the radial pieces are massive. I have found only one Polian vesicle. Théel records seven from the "Challenger" specimen, but this difference is not of importance. It is interesting to note that the stone canal is very similar to that of *H. spinifera*, both in its position and large size. Both branches of the respiratory tree extend to the anterior end of the body, but the left branch is the larger. Cuvierian organs are present.

Spicules.—These consist of tables and knobbed buttons. The discs of the table differ slightly from Théel's drawings, in that they often have more holes and the edge of the disc is more irregular. The disc has a diameter of 100 μ, and generally contains a large central hole surrounded by smaller holes, but occasionally the disc is irregularly perforated and contains numerous small holes instead of the single central hole. The buttons are 65 μ long and have three pairs of holes. In the papillæ there are a few tables of the usual type, and a large number of massive rods perforated at each end, and having a flattened perforated centre.

General Distribution.—Indian Ocean.

Remarks.—This species is undoubtedly related to *H. spinifera*. The external differences are not very great, the colouring of *H. ocellata* being generally more decided than that of *H. spinifera*. The disposition of the papillæ is the

same in both species, but the large lateral papillæ of *H. ocellata* are larger than those of *H. spinifera*. The spicules of both species belong to the same general type. There is evidently much variation in the tables of the two species, and the tables of the Ceylon specimens of *H. spinifera* agree almost as well with Théel's drawings of *ocellata* as with those of *spinifera*. The latter, however, differs from the former in having tables bearing large spine-like towers in the papillæ. Also the buttons of *ocellata* are larger than those of *spinifera*. Internally there does not appear to be much difference. The calcareous ring presents some small points of difference, but both species agree in having an extremely large stone canal.

There are two small Holothurians from the Seychelles sent by Professor Stanley Gardiner, the largest being only 40 mm. in length. These two specimens agree very closely with *H. ocellata* in external appearance, in the form of the calcareous ring, and in the curious large stone canal. The tentacles and the greater part of the alimentary canal are absent from both specimens. Nevertheless they differ considerably in the nature of the spicules, and I have had some difficulty in deciding upon the identity of the two specimens. The spicules consist of tables and buttons. The tables are of two sizes, smaller tables not unlike those of a typical *H. ocellata*, forming a superficial larger, and longer tables, apparently situated at a lower level. These larger tables generally have a complete circular disc, but often it is incomplete, and forms a cross-shaped base to the table as in *H. kurti* (see Pearson, 33).

The discs of the smaller tables have a diameter of 100 μ, and are pierced by twenty or more holes and have an undulating margin. The larger tables are not very common. The disc has a diameter of about 250 μ and contains a very large number of holes. Both kinds of tables have towers similar to those found in the typical deposits of *H. ocellata*. The buttons are delicate and have about seven pairs of holes. Many of the buttons are apparently knobbed. Although the spicules are somewhat similar to those of *H. kurti*, I am confident that this form does not belong to that species. The discs and towers of the tables of *H. kurti* are much more robust than those of the specimens under examination.

I am inclined to believe that the specimens are young forms of *H. ocellata*, and the differences in the spicules are probably due to the fact that as the animal grows older the spicules become smaller owing to disintegration. This has been observed in other species by Mitsukuri and the present writer.

Holothuria martensii, Semper.

(Plate XIV., fig. 25.)

Holothuria martensii, Semper 1868 (38) ; Ludwig 1882 (26) ; Lampert 1885 (19) ; Théel 1886 (42) ; Pearson 1910 (34).

A few specimens from the Australian and American Museums.

External Characters.—The preserved specimens I have been able to examine have exactly the same appearance as *Holothuria spinifera*, but as I have only examined living specimens of the latter and not of the former, I cannot say whether the resemblance is as close during life. The colour of a specimen preserved in spirit is a uniform yellowish-white both above and below. The body is covered with papillæ, which are larger along each side of the body than elsewhere.

Internal Structure.—Internally the resemblance with *Holothuria spinifera* is maintained. The calcareous ring is similar in shape and size. There is a single long Polian vesicle and a very large stone canal similar to that already described in *H. spinifera* and *H. ocellata*, the only difference being that the free end is pear-shaped as in the specimen described by Théel. Both Semper and Lampert have described the presence of two Polian vesicles and one extremely small stone canal. In specimens examined by me the stone canal is large in every case, and there is only one Polian vesicle. On these points I am in agreement with Théel. It would seem as though Semper and Lampert had mistaken the stone canal for a Polian vesicle, to which it offers a distinct resemblance. Such being the case it is difficult to know what structure they have interpreted as "der Steinkanal ausserst klein." The right

branch of the respiratory tree is larger than the left. There are Cuvierian organs present, in which character this species agrees with *Holothuria ocellata*. Cuvierian organs have not yet been recorded in *Holothuria spinifera*.

Spicules.—These consist of massive tables and knobbed buttons. The buttons are the same as those of the other two related species, but the tables are different. The tables are characterized by having extremely high towers, each consisting of four uprights and about eight cross-pieces. The tower is surmounted by numerous teeth. Height of tower 125 μ. The disc of the tower is perforated irregularly by about twenty or more holes and has a diameter of 120 μ. The supporting rods in the papillæ are similar to those in *Holothuria ocellata*. *Holothuria martensii* differs, therefore, from *H. ocellata* and *H. spinifera* in the nature of the tables, in the general integument, and from the latter species in having no tables bearing large spines in the papillæ.

General Distribution.—East Indies, Ceylon, and Australia.

Holothuria albiventer, Semper.

(Plate XIV., fig. 26.)

Holothuria albiventer, Semper 1868 (38) ; Lampert 1885 (19), 1895 (21) ; Théel 1886 (42) ; Hérouard 1893 (13) ; Ludwig 1899 (29) ; Sluiter 1901 (41) ; Pearson 1910 (34).

Several specimens, collected by Professor Stanley Gardiner in the Maldives.

External Characters.—The ambulacral appendages consist of papillæ only, those on the dorsal side being small and numerous, those on the ventral side being larger and less closely arranged. In the spirit specimens at my disposal the bivium is clearly marked from the trivium, not only by the disposition of the papillæ mentioned above, but also by the difference in colour. The general colour is grayish-brown, but the trivium is lighter, especially on the papillæ. In Semper's description of the living animal he gives the colour as follows :—Bivium,

greenish-brown with irregular light patches and an indefinite dark patch. The lower surface, dark gray with numerous white patches. Papillæ, on the bivium gray, those on the trivium white.

Internal Structure.—As in the three previous species the stone canal is exceptionally large, and arises from the right side of the dorsal mesentery. There is a single Polian vesicle. The stone canal is similar to that of the three previous forms. Cuvierian organs are evidently not present in this species, since they are not mentioned by previous writers, and there are none present in the specimens under examination.

Spicules.—These are very characteristic, and consist of tables and knobbed buttons in the general integument. The knobbed buttons have the usual three pairs of holes and are 40 μ in length. The tables are peculiar in that the tower is supported by numerous uprights. The base of the tower is perforated irregularly and is 90 μ in diameter. The height of the tower is 85 μ, and the top is surmounted by numerous spines.

General Distribution.—Indian Ocean, particularly common along the east coast of Africa.

Remarks.—Hérouard (13) expressed the opinion that *H. aculeata*, Semper, together with *H. bowensis*, Ludw., and *H. modesta*, Ludw., should be included in *H. albiventer*, Semper. Ludwig, Lampert, and Sluiter have rightly shown that *H. albiventer* differs from all these species in the form of its massive tables. Since the four species described above—namely, *Holothuria spinifera*, *Holothuria ocellata*, *Holothuria martensii*, and *Holothuria albiventer*—show such close relationship in many respects I append a key to the four species :—

Common characters.—Ambulacral appendages papillæ only, which are situated upon non-contractile eminences. Extremely large stone canal arising from the right side of the dorsal mesentery.

(1) Tables in general integument having more than four upright supports. Papillæ along both sides of body not larger than rest.
. . . . . *H. albiventer.*

(2) Tables having only four upright supports. Papillæ along sides of body larger than rest.

(A) Tables in papillæ having large spine-like superstructure.

..... *H. spinifera.*

(B) Absence of large spine-like towers in papillæ.

(*a*) Tables in general integument short and having only one transverse bar.

..... *H. ocellata.*

(*b*) Tables in general integument high and having four or more transverse bars.

..... *H. martensii.*

Literature.

1. *Augustin, E.*—1908, "Über Japanische Seewalzen." Abhand. d. Math-Phys. Klasse der K. Bay. Akad. d. Wiss., II. Suppl. Bd., I. Abhand.
2. *Bedford, F. P.*—1898, "Holothurians collected by Mr. J. Stanley Gardiner at Funafuti and Rotuma." Proc. Zool. Soc., 1898.
3. ————————1899, Holothurians in Willey's Results, Part II.
4. *Bell, F. J.*—1884, Zoological collections of H.M.S. "Alert." Echinodermata.
5. ————————1887, "Echinodermata from the Andaman Is." Proc. Zool. Soc., 1887.
6. ————————1887, "The Echinoderm fauna of the Island of Ceylon." Sci. Trans. Royal Dublin Soc., Vol. III. (ser. 2).
7. ————————1889, "On the Holothurians of the Mergui Archipelago, collected by Dr. John Anderson." Journ. Linn. Soc. (Zoology), Vol. XXI.
8. *Brandt, J. F.*—1835, "Podromus descriptions animalium ab. H. Mertensio observatorium." Fasc. I. Petropoli, 1835.

9. *Clark, H. L.*—1901, "The Echinoderms of Porto-Rico." Bull. U. S. Fish Comm. for 1900, II.

10. ————————1902, "Echinodermata. Papers from the Hopkins Galapagos Exp. 1898–99, XII." Proc. Wash. Acad., IV.

11. *Fisher, W. K.*—1907, "The Holothurians of the Hawaian Is." Proc. U. S. Nat. Mus., Vol. XXXII.

12. *Haacke, W.*—1880, Holothurien, in Beitrage zur Meeresfauna der Inseln Mauritius und der Seychellen, &c.

13. *Hérouard, E.*—1893, "Holothuries de la Mer Rouge." Arch. de Zool. exper. et gen. 3 ser. T. 1.

14. *Jäger, G. F.*—1833, "De Holothuriis." Diss. inaug. Turici.

15. *Koehler, R.*—1895, "Echinodermes de la Baie d'Amboine." Rev. Suisse de Zool. t. III., 1895–96.

16. ————————1895, "Catalogue raisonné des Echinodermes recueillis par M. Korotnev aux Îles de la Sonde." Mem. de la Soc. Zool. de France, T. VIII.

17. *Koehler, R., & Vaney, C.*—1908, "Littoral Holothurioidea collected by the 'Investigator,' Calcutta."

18. *Koningsberger.*—1904, "Tripang en Tripangvisscherij in Nederlandsch-Indië." Med. plantenuin Java, LXXI.

19. *Lampert, K.*—1885, Reisen im Archipel der Philippinen. Bd. 4, Th. 3, "Die Seewalzen."

20. ————————1889, "Die wahrend der Expedition der Gazelle gesammelten Holothurien." Zool. Jahrb. Bd. IV.

21. ————————1895, "Die von Dr. Stuhlmann in der Jahren 1888 und 1889 an der ostkuste Afrikas gesammelten Holothurien." Mitt. aus dem Naturh. Mus. Hamburg. XIII., 1895–96.

22. *Lesson, R. P.*—1830, "Centurie Zoologique ou choix d'animaux rares, nouveaux ou imparfaitement connus." Paris.

23. *Ludwig, H.*—1875, "Beitrage zur Kenntniss der Holothurien." Arb. aus dem Zool.-Zoot.-Inst. Wurz. Bd. II., 1875.

24. ————————1880, Echinodermata in Kossmann's Reise nach dem Rothen Meere, V., 1880.

25. ————————1881, Revision der Mertens-Brandt'schen Holothurien." Zeit. f. Wiss. Zool. Bd. XXXV., 1881.

26. ————————1882, "List of the Holothurians in the collection of the Leyden Museum." Notes from the Leyden Museum, Vol. IV.

27. ————————1883, "Verzeichniss der Holothurien des Kieler Museums." 22 Bericht d. oberhess. Ges. f. Natur-u. Heilekunde. Giessen, 1883.

28. ————————1887, "Die von G. Chierchia auf der Fahrt der Kgl. Ital. Corvette. 'Vettor Pisani.' gesammelten Holothurien." Zool. Jahr. (Abth. f. Syst.), Bd. II.

29. ————————1887, "Drei Mittheilungen über alter und neue Holothurien arten." Sitz. der Kgl. Preuss. Ak. d. Wiss., Berlin.

30. ————————1888, "Die von Dr. J. Brock im Indischen Archipel gesammelten Holothurien," Zool. Jahrb. (Abth. f. Syst.), Bd. III.

31. ————————1898, "Die Holothurien der Sammlung Plate." Zool. Jahr. Suppl., Bd. IV.

32. ————————1899, "Echinodermen des Sansibargebietes." Abh. Senckenberg. Ges. XXI., 1897–99.

33. *Pearson, J.*—1903, "Holothurioidea" in Herdman's Report on the Ceylon Pearl Oyster Fisheries, Vol. I., Supplementary Report, No. V.

34. *Pearson, J.*—1910, Holothurioidea of Kerimba Archipelago, Portuguese East Africa, collected by J. J. Simpson. Proc. Zool. Soc., 1910.

35. ————————1910, Holothurioidea of Mergui Archipelago, Lower Burma, collected by J. J. Simpson and R. N. Rudmose-Brown. Proc. Zool. Soc., 1910.

36. *Quoy et Gaimard.*—1833, Voyage de l'Astrolabe, Zoologie. T. IV., Paris, 1833.

37. *Selenka, E.*—1867, "Beiträge zur Anatomie und Systematik der Holothurien." Zeit. f. wiss. Zool., Vol. XVIII.

38. *Semper, C.*—1868, Reisen im Archipel der Philippinen, Bd. 1, Th. 2, "Holothurien."

39. *Sluiter, C. Ph.*—1887, "Holothurien des Java-Meeres." Nat. Tijd. v. Nederlandisch-Indie, Vol. XLVII.

40. ————————1890, "Echinoderm Fauna des Java-Meeres Nat. Tijd. v. Nederland-Indie." Vol. XLIX.

41. ————————1901, "Die Holothurien der Siboga Expedition." Siboga-Expeditie, XLIV., Leiden.

42. *Théel, Hj.*—1886, "Report on the Holothurioidea, Part II." Report on the Scientific Results of the Voyage of H.M.S. "Challenger," Vol. XIV., Part XXXIX.

43. *Thurston, E.*—1890, "Notes on the Pearl and Chank Fisheries and Marine Fauna of the Gulf of Mannar." Madras, 1890.

44. *Voeltzkow.*—1902, "Die von Aldabra bis jetzt bekannte Flora und Fauna." Abh. Senckenb. Ges. XXVI.

45. *Whitelegge.*—1897, "Echinodermata of Funafuti." Mem. Austr. Mus., III., Pt. II.

46. ————————1903, "Notes on the Zoology of Paonopa or Ocean Is. and Naru or Pleasant Is., Gilbert Group. Echinoderms." Rec. Austr Mus., V.

Explanation of Plates.

Plate V.

Holothuria hamata, n. sp., from the dorsal side. × 1.

Plate VI.

Holothuria hamata, n. sp.
Fig. 2*a*.—View of table from below. × 600.
Fig. 2*b*.—Side view of table. × 600.
Figs. 2*c*, 2*d*.—Knobbed buttons. × 600.
Fig. 2*e*.—Calcareous ring. × 4½.

Holothuria maculosa, n. sp.
Fig. 3*a*.—View of table from below. × 500.
Fig. 3*b*.—Side view of table. × 500.
Fig. 3*c*.—View of table from above. × 300.
Fig. 3*d*.—Knobbed button. × 500.
Fig. 3*e*.—Spicules in neighbourhood of papillæ. × 500.
Fig. 3*f*.—Perforated rods from the papillæ. × 500.
Fig. 3*g*.—Calcareous ring. × 4.

Plate VII.

Holothuria marmorata (Jäger).
Figs. 4*a*, 4*b*, 4*c*.—Typical spicules. × 1,000.
Fig. 4*d*.—Spicules from the deeper hypodermis. × 1,000.
Fig. 4*e*.—Calcareous ring. × 2.

Holothuria argus (Jäger).
Figs. 5*a*, 5*b*.—Supporting rods from pedicels. × 400.
Fig. 5*c*.—H-shaped spicule from pedicel. × 500.
Figs. 5*d*, 5*e*, 5*f*, 5*g*.—Typical spicules. × 1,000.
Fig. 5*h*.—Calcareous ring. × 2.

Holothuria vitiensis, Semper.
Fig. 6*a*.—H-shaped spicule from pedicel. × 500.
Figs. 6*b*, 6*c*.—Supporting rods from pedicels. × 500.
Figs. 6*d*, 6*e*, 6*f*.—Typical spicules. × 1,000.
Fig. 6*g*.—Calcareous ring. × 2.

Plate VIII.

Holothuria graffei, Semper.
Figs. 7*a*, 7*b*, 7*c*.—Spicules. × 1,000.
Fig. 7*d*.—Spicule. × 750.
Fig. 7*e*.—Calcareous ring. × 2.

Holothuria glaberrima, Selenka.
Figs. 8*a*, 8*b*, 8*c*.—Spicules. × 600.
Fig. 8*d*.—Calcareous ring. × 8.

Holothuria lubrica, Selenka.
Fig. 9*a*.—Calcareous ring. × 3.
Figs. 9*b*, 9*c*, 9*d*.—Spicules. × 450.

Plate IX.

Holothuria cinerascens (Brandt).
Figs. 10*a*, 10*b*, 10*c*.—Various views of tables. × 500.
Fig. 10*d*.—Calcareous ring. × 4.
Fig. 10*e*.—Rod-shaped spicule. × 400.

Holothuria atra, Jäger.
Figs. 11*a*, 11*b*, 11*c*.—Various views of tables. × 650.
Fig. 11*d*.—Calcareous ring. × 3.
Fig. 11*e*.—Perforated plate. × 650.

Holothuria edulis, Lesson.
Figs. 12*a*, 12*b*.—Tables. × 650.
Fig 12*c*.—Perforated plate. × 650.
Fig. 12*d*.—Calcareous ring. × 6.

Plate X.

Holothuria monacaria (Lesson).
Figs. 13*a*, 13*b*.—Tables. × 750.
Fig. 13*c*.—Button. × 750.
Fig. 13*d*.—Calcareous ring. × 7.

Holothuria vagabunda, Selenka.
Figs. 14*a*, 14*b*.—Tables. × 1,000.
Fig. 14*c*.—Button. × 750.
Fig. 14*d*.—Calcareous ring. × 6.

Holothuria fusco-cinerea, Jäger.
Fig. 15*a*.—Calcareous ring. × 5.
Fig. 15*b*.—Table. × 750.
Figs. 15*c*, 15*d*, 15*e*.—Buttons. × 750.

Plate XI.

Holothuria fusco-rubra, Théel.
Fig. 16*a*.—Table. × 1,000.
Figs. 16*b*, 16*c*, 16*d*.—Buttons. × 1,000.
Fig. 16*e*.—Calcareous ring. × 6.

Holothuria pardalis, Selenka.
Figs. 17*a*, 17*b*.—Tables. × 500.
Figs. 17*c*, 17*d*, 17*e*.—Buttons. × 500.
Fig. 17*f*.—Calcareous ring. × 7.

Holothuria maculata (Brandt).
Figs. 18*a*, 18*b*, 18*c*.—Tables. × 400.
Fig. 18*d*.—Button. × 400.
Fig. 18*e*.—Calcareous ring. × 3½.

Plate XII.

Holothuria rugosa, Ludwig.
Figs. 19*a*, 19*b*, 19*c*.—Tables. × 550.
Figs. 19*d*, 19*e*, 19*f*.—Buttons. × 550.
Fig. 19*g*.—Calcareous ring. × 6.

Holothuria discrepans, Semper.
Figs. 20*a*, 20*b*.—Tables. × 900.
Fig. 20*c*.—Button. × 900.
Fig. 20*d*.—Calcareous ring. × 12.

Holothuria hamata, n. sp.